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TERTIARY ARCHHELENIS

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THE *Archhelenis-theory* of von Ihering has now received so much support from various sides that we may regard it as firmly established with regard to its general correctness. Stated in broad terms, this theory assumes a former land connection between Africa and South America, which is rather old. This connection is the last remnant of a large southern continental mass (South Atlantis, Gondwana-land), which existed since the beginning of the organic history of the earth (Cambrium), which was broken to pieces at different times, and the remnants of which are now found in Australia, India, Africa and Brazil. The separation of Brazil from Africa was the last step in the dismemberment of this old continent, an event which is placed by most writers toward the end of the Mesozoic era, although some have admitted the possible continuation of Archhelenis into the beginning of the Tertiary.

Recently, von Ihering has tried to fix the time of the disappearance of the connection between Africa and Brazil more exactly, and arrived at the conclusion that Archhelenis *persisted* at least through the *Eocene*. He discusses the question chiefly in connection with his studies on the marine fauna of the Patagonian beds, which he regards as Eocene.[1] Comparing this fauna with the contemporaneous Tertiary faunas of the rest of the world, he discovers certain facts, which, according to him, can not be explained except by the assumption that Archhelenis was still in existence at the beginning of the Tertiary.

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[1] Ihering, H. von, "Les Mollusques fossiles du Tertiaire et du Crétacé supérieur de l'Argentine," *Anal. Mus. Buenos Aires,* 14, 1907.

I fully accept the facts of the faunistic relations of the Patagonian beds, as laid down by von Ihering. Yet I do not believe that they demonstrate the necessity of assuming the existence of Archhelenis at that time, but, on the contrary, I believe *that they point just to the opposite,* namely, that at the time when the Patagonian beds were deposited (in the early Tertiary—it does not matter, for the present purpose, whether we regard the beds as Eocene or younger) the connection between Brazil and Africa must have disappeared, and that there must have been a deep ocean in its place.

Of the relations of the Patagonian fauna to other faunas, the following are mentioned by von Ihering as most important (p. 76 ff.).

While the Patagonian fauna in general is very peculiar, and consists preeminently of southern (antarctic) elements, yet there are certain affinities to Tertiary faunas of the northern hemisphere. But there are hardly any relations to North America, and the few affinities with northern faunas are rather with the *Indo-European fauna.* This, of course, means that the Indo-European forms, which may be regarded as constituting resemblances with the Patagonian fauna, are *not* found in North American Tertiaries. Von Ihering believes that these peculiar conditions are to be accounted for by the existence of a land barrier between the North and the South Atlantic, which prevented a migration of North American marine forms to Patagonia, while there was a possibility for Patagonia to receive Indo-European types from the Indian ocean along the eastern coast of Africa and the southern coast of the Atlantic land-connection (Archhelenis).

While I do not doubt the correctness of the view that Patagonia did not receive the Indo-European elements of its fauna by the direct way, from the Mediterranean across the Atlantic, I think, the fact of the *absence* of these forms from North America is not correctly understood and interpreted by von Ihering. If Archhelenis existed at that time, there must have been *a coast line* not only in the south, but also in the north of this land, *running across the present Atlantic from North Africa to the West Indies.* Since the forms under discussion are most emphatically marine littoral-shells, such a coast line would have favored their migration from the European waters to those of the West Indies and North America. Thus these forms, which are found both in the Patagonian and in the Indo-European Tertiaries, should have been able, by all means, to reach also North America. The fact, however, that they are absent in the latter parts indicates decidedly, that there was no possibility for them to go across the Atlantic from Europe to America, and thus there can not have been a coast line or a land connection between Africa and South America, but there must have existed a deep ocean (the Atlantic), which prevented their migration from Europe to North America as well as from Europe by the direct way to Patagonia.

One fact, however, remains now unexplained, namely, the absence of North American types in Patagonia. If the Atlantic Ocean extended uninterruptedly from north to south, as it does now, there must have been, disregarding small interruptions at Panama and in the region of the Amazonas, a rather continuous shore line, along which the northern forms could have migrated to Patagonia. I think such a north-south migration actually took place, but it did not reach the southern extremity of South America on account of climatic differentiations along this coast line. Von Ihering points out (p. 492) that the Patagonian fauna is characterized by the absence of certain types of shells, which are preeminently tropical. This very strongly suggests that the Patagonian Tertiary seas were not of a tropical, but of a subtropical or even temperate, character. If this is true, it is apt to furnish an explanation for the absence of North American forms in Patagonia. The North American fauna of the Tertiary is found from Florida to New

Jersey, and some of the richest deposits are in Florida and Alabama, parts which surely had a tropical climate in the beginning of the Tertiary. If Patagonia was extratropical, we can not expect that this fauna should have reached it, for its southward migration would have been stopped by the southern boundary of the tropical belt.

On the other hand, von Ihering points out that, while there was no immigration of tropical West Indian and North American types during the Patagonian time, such an immigration took place later, when the Entrerios beds were deposited (which he believes to be Miocene), for we find such forms in these beds. He thinks that it is thus demonstrated that the destruction of Archhelenis falls in the time between the deposition of the Patagonian and Entrerios beds. I can not admit this, for the Patagonian beds are found far to the south (between 45 and 50° S. lat.), while the Entrerios beds are in 30–35° S. lat. It is true, there are localities for Entrerios beds farther to the south (as far as about 43° S. lat.), but of the characteristic tropical types, which are named by von Ihering (on p. 361) not a single one is found at these southern localities (see table on pp. 357 and 358). Thus it is very probable that, while at the time and the locality of the deposition of the Patagonian beds an extratropical climate prevailed, a tropical climate may have existed at the same time farther north (north of say about 40° S. lat.). However, we do not know the corresponding deposits of these parts, and we only know that there are tropical immigrants in later deposits in about 30–35° S. lat., but this does not prove that there were no such in the northern parts of Argentina at the time of the deposition of the Patagonian beds. In fact, the presence of certain tropical types in the Navidad beds of Chile (p. 514), which very much resemble the Patagonian beds in general character, but are situated a good deal farther north, suggests strongly, that the Navidad beds are the tropical "facies" of the Patagonian beds. I do not think that a separation of the Patagonian and Chilean sea by land is to be assumed for the explanation of the absence of these tropical types in the Patagonian beds, as von Ihering is inclined to do (p. 495). Of course, the Patagonian beds were deposited on the east side, those of Navidad on the west side, of the old peninsula extending northward, and now represented by the Chilean Coast Cordilleras, but this peninsula had an end somewhere to the north, and around this point a communication of the two seas was possible, till the elevation of the Cordilleras de los Andes took place, and connected the old Chilean land with the land lying to the east of it.

Further, if there was no connection of Africa and Brazil any more in Tertiary times, the migration of the Indo-European forms to Patagonia by the route indicated above (East Africa, and south coast of Archhelenis) was impossible. Yet there is another way open. As von Ihering points out (p. 81), this Indo-European fauna reached eastward to Australia and the Pacific Islands, and thus it very likely does not originally belong to the fauna of the old Tethys (Mediterranean, North Atlantic, West Indian seas), but consists of old Pacific elements which extended, in the Tertiary, eastwards into the Mediterranean part of the Tethys (Europe). The very absence of these types in the West Indies and in North America supports this view. And further, since the Antarctic fauna, to which the Patagonian fauna shows the closest affinities, is nothing but an offshoot of the old Pacific fauna, the relations of the Patagonian to the Indo-European forms find thus their explanation, and the way, by which these faunas are connected, apparently goes over Australia and Antarctica.

Finally, for the non-existence of Archhelenis in the Eocene very recently a new line of evidence has been introduced. Stromer[2] points out that recently quite a number of marine Eocene deposits have been discovered in West Africa, namely, in the region south of Senegambia; on the middle Niger River; in the southern central Sahara and in northern Nigeria; in Togo and Cameron (Gulf of Guinea); and even as far south as the Gabun, Angola and Mossamedes. Although these deposits are rather scattered, their Mediterranean character has been recognized, so that it appears as very probable that they belong to a continuous sea, which extended south from western Europe along the west African coast. That is was actually continuous is demonstrated, according to Stromer, by the distribution of the Nummulites in these beds, which are found only in the north, and indicate a cold northward current along the west African coast: such a current could develop only under a similar distribution of land as at present, namely, if the west African coast extended uninterruptedly from south to north, as it now does. This, of course, would show that the Atlantic at that time existed approximately in its present form, its northern (Tethys) and southern (Nereis) parts being connected, and that the separating land bridge, Archhelenis, had disappeared.

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[2] Stromer, E., "Ueber Alttertiaer in Westafrika und die Suedatlantis," *Jahrb. kgl. Preuss. Geol. Landesanst.*, 30, 1909, p. 511 ff.

All the above considerations lead us only to one conclusion: that *in the beginning of the Tertiary Archhelenis had ceased to exist, and that there was no connection any more between South America and Africa.* Indeed, the facts introduced by von Ihering in support of his assumption of the existence of this land-bridge in the Eocene, prove to be, under renewed critical investigation, *the strongest evidence for the contrary,* and it has been shown above that also some other facts, which apparently contribute to the support of von Ihering's view, may be easily understood under the assumption that *Archhelenis had been destroyed at the beginning of the Tertiary time.*